THE SYSTEM AND THE SOFTWARE

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SCHOOL OF COMPUTER TRAINING

PROGRAMMING IN BASIC
STUDY UNIT 3

THE SYSTEM AND THE SOFTWARE

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Edition 2

STUDY UNIT 3

YOUR LEARNING OBJECTIVES

WHEN YOU COMPLETE THIS UNIT, YOU WILL BE ABLE TO:

☐ Understand how data is recorded onto media such as cards, magnetic tape and disks . . . . . **Pages 1–8**

☐ Know some of the advantages and disadvantages of using audiotapes as opposed to floppy disks . . . . . **Pages 5–6**

☐ Know the difference between recording on magnetic disk using the cylinder track method and the sector method . . . **Pages 7–8**

☐ Compare the quality of dot matrix and letter-quality single character printers . . **Pages 13–15**

☐ Identify several disk drive options available to micro owners . . . . . **Pages 15–17**

☐ Understand the differences in data organization, including files, records and fields . . . . . **Page 22**

☐ Understand the programming cycle . . . . . **Pages 23–25**

STUDY UNIT 3

THE SYSTEM AND THE SOFTWARE

DO YOU KNOW?

- **All the various components of a computer system?**
- **What "real time" processing is?**
- **What "GIGO" is?**

GETTING INFORMATION INTO AND OUT OF THE COMPUTER

We have seen how data is stored in computer memory as a series of bits, with eight bits being grouped into one byte. Now, we will show how data is made available to the Central Processing Unit (CPU) and how the results of processing can create useful information.

From now on, we will often refer to the basic data processing cycle: *input*, *processing*, and *output*. Input is the step in which data is made available to the CPU, which, under control of a program, will manipulate the data (processing). The final results of our processing will then be displayed, printed or stored during the step known as output.

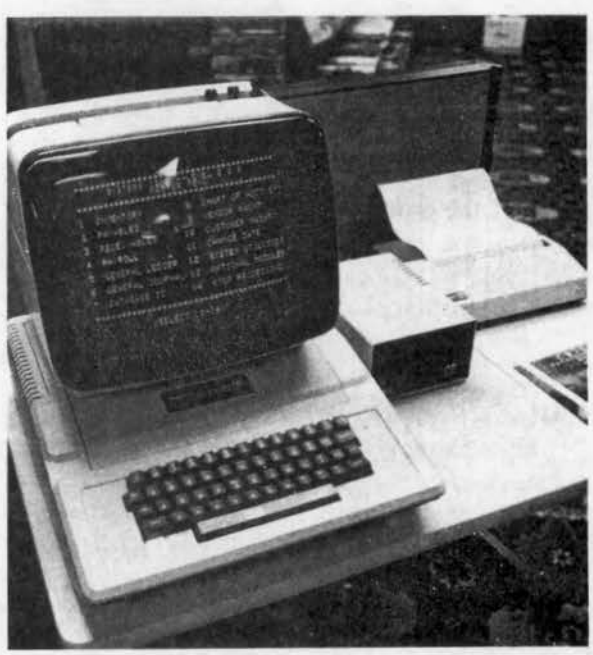
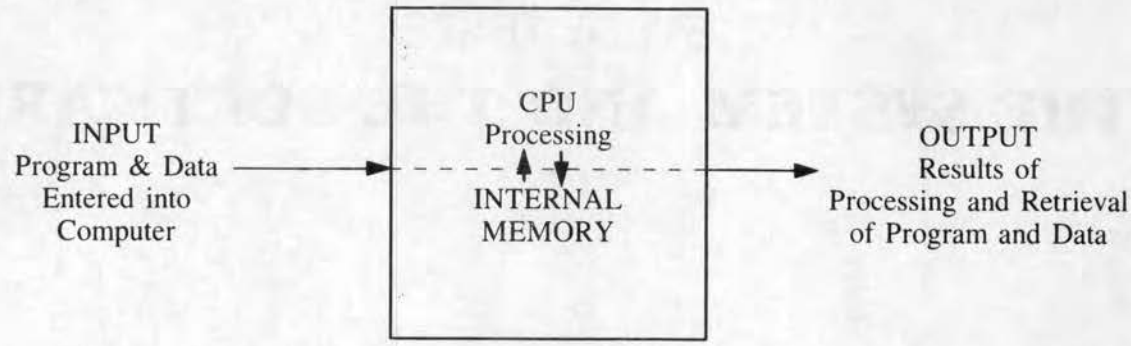


FIGURE 1—This is an example of a complete system. There is a keyboard, screen, disk port for auxiliary storage, and a small printer.



INPUT

The human brain receives a variety of input from the senses: sight, touch, taste, smell, and sound. The computer ''brain'' is less sophisticated. Its input must be received in a format which can be converted into discrete bit patterns representing characters and machine instructions.

INPUT DEVICES

There are many different types of input devices, but they all serve the same general purpose: they present data to the CPU for processing. Some of these devices sense holes punched into cards; some interpret prerecorded magnetized spots; and, a few can even read handwritten or machine written characters.

CARD READER

For many years, the most common input device was the card reader. The card reader ''senses'' coded punches or holes in cards and translates them into the bit patterns recognizable by the CPU.

The card reader does not read the cards in the same way we humans read printing. Rather, rectangular punches in special locations are all that the computer can sense.

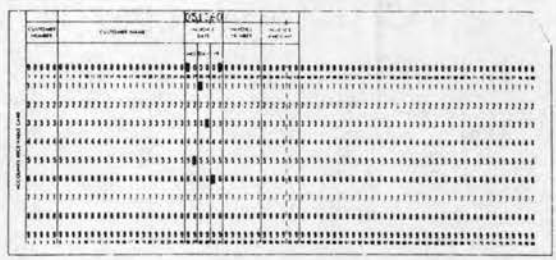


FIGURE 2—The IBM card has 80 card columns which can be used for coding locations of data. These 80 locations are marked consecutively across the face of the card from left to right.

One letter, number or special character can be recorded in each location. (Does that remind you of a part of computer memory? Remember that one byte of memory can hold the same information as one card column. When a card is ''read'' into main memory storage, it takes 80 bytes to hold all the data.)

Just as the EBCDIC code is used to represent characters in RAM, the Hollerith code is used to record data onto cards. Each character has from one to five punches in one card column.

Each vertical column is divided into 12 positions or rows. Ten of these rows are printed on the face of the card: they are the digit punches Ø sequentially through 9.

HOLLERITH'S PUNCHED CARD CODE

Character	Zone	Digit
A	12	1
B	12	2
C	12	3
D	12	4
E	12	5
F	12	6
G	12	7
H	12	8
I	12	9
J	11	1
K	11	2
L	11	3
M	11	4
N	11	5
O	11	6
P	11	7
Q	11	8
R	11	9
S	Ø	2
T	Ø	3
U	Ø	4
V	Ø	5
W	Ø	6
X	Ø	7
Y	Ø	8
Z	Ø	9
Ø		Ø
1		1
2		2
3		3
4		4
5		5
6		6
7		7
8		8
9		9

FIGURE 3—Examine this chart to gain an understanding of how characters are entered or punched on the cards. For example, the letters A through I have a punch in the top or 12 row and a digit punch (1 through 9). Letters J through R have an 11 row punch and one of the nine digit punches. The letters S through Z have a punch in the Ø row and a digit punch ranging from 2 to 9.

The other two rows are located in the space above the digit punches along the top of the card. The 12 row is immediately under a printing zone and the 11 row is just below it (and just above the Ø row). Remember, since the printing does not matter to the computer, it is not important for us to see the 12 and 11 row.

A number is recorded on a card by punching the appropriate digit punch (Ø through 9). A letter of the alphabet is coded with two punches in a column.

The coding punches used in the Hollerith code are quite similar to those of the EBCDIC code. This should not be too surprising, since the Hollerith Code was well known to the creators of the EBCDIC code!

Special characters have their own combination of punches (or no punches, which is how a "blank" such as a space between words is punched).

HOW PUNCHES ARE RECORDED

The keypunch machine is a device which punches holes onto a card in response to the key pressed by the operator on a keyboard (much like a typewriter keyboard). Information to be recorded is "keyed" from source documents (such as forms) by data-entry operators.

Let's look at a typical example of how the data recording process works. In a bank, data must be captured from many different types of transactions. Everyday exchanges such as savings deposits, withdrawals, loan payments, check cashing, and similar activities must be recorded.

Normally, each of these transactions is written in a particular form on special paper. Each form is designed to capture essential data. Such information as branch number, account number, type of transaction, amount of money, etc. is included.

This transaction form will immediately or later be keyed onto a machine-readable medium either by the same teller or by a data-entry operator within the bank. Errors at this end of the data processing cycle could be critical.

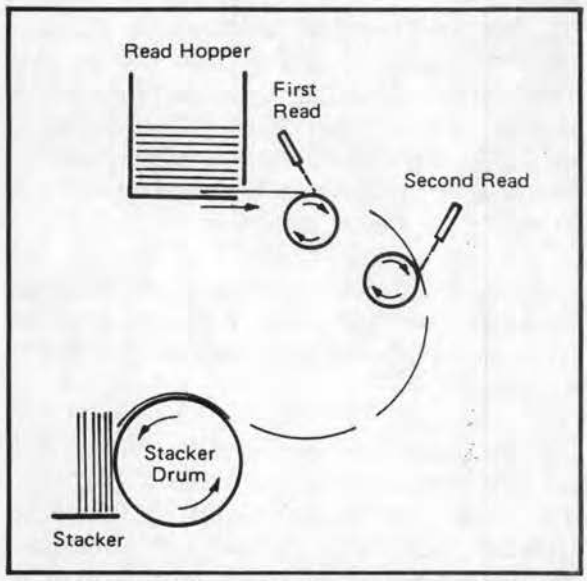


FIGURE 4—When data from cards is fed from the keypunch machine into computer storage, a reader is used. Punched cards are placed in the read hopper and moved past one or more reading sensors. The one shown here has two reading stations: the second reader is used to verify the information already read by the first station. Any disparity will cause the machine to signal the operator that the data on this card is unclear.

Very often so-called "computer errors" are nothing more than errors in data entry. To minimize these keying errors, verification procedures are used.

A verifier is a machine which checks the accuracy of punched cards. The operator of the verifier rekeys the data working from the same form that the original data entry operator used. The verifier notes, through the use of notches in the card, any discrepancy found between the two entries. If none are found, the original card is said to be good; in case of a discrepancy, a closer examination of the form should prove which version is correct.

The verification process described here does have its limitations, however. If the account number is incorrect on the original deposit slip, the amount of the deposit could still be credited to the wrong account.

TAPE ON REELS CASSETTES AND CARTRIDGES

Cards are not the only medium for recording programs and data. There are other media which are machine-readable. Iron oxide coated plastic can be magnetized at discrete positions corresponding to card columns.

This type of media is especially well suited to storing large files of data. Data is recorded onto the media in key-to-tape and key-to-disk processes very similar to the keypunch operation.

Magnetic Tape

One efficient way to store programs and data is on magnetic tape. This tape can be in several different formats, but the two most popular are cassettes and reel-to-reel.

Magnetic tape is composed of mylar plastic coated with an iron oxide film. This coating is capable of being magnetized in discrete locations. Each tape is divided into channels, corresponding to punching positions on an IBM 80-column card. But whereas a card can hold a maximum of 80 characters (one character per column), the number of characters which can be stored on tape depends upon the length and density of the tape.

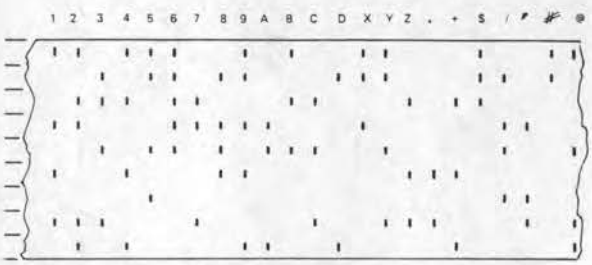


FIGURE 5—Magnetic tape contains nine channels on which data may be recorded. The data is actually a magnetized spot of iron oxide which is "read" when the tape is played on the tape drive component.

Tape density is measured as a number of bytes per inch (BPI). Depending on the type of device employed, tape densities can vary from 800 BPI up to 6,250 BPI.

The storage capacity of a tape, then, is the product of the length of the tape (measured in inches) times the tape density. For example, a

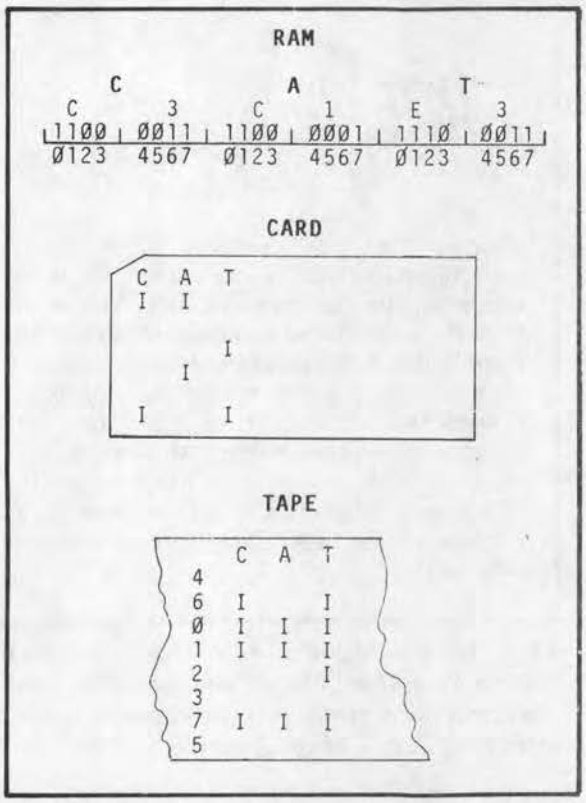


FIGURE 6—Compare the way a word would be coded onto three different media. Notice how the word "cat" is coded into RAM, on a punched card and on magnetized tape.

2400 foot reel of tape fully recorded with data at 800 BPI would hold about 2.3 M. (The "M" equals megabytes, or millions of bytes.)

800 BPI × 12 inches per foot ×
2400 feet = 23,040,000.

TAPE TRANSFER RATES

The speed at which data is transferred between RAM and tape depends on two factors: the tape density and the speed of the tape. We have already discussed tape density as being the number of characters storable on an inch of tape (BPI). The speed at which the tape physically moves, position by position, across the read/write heads can vary from several to 200 or more inches per second.

To figure out tape transfer rates, the following formula is applied:

TRANSFER RATE (byte/second) =
DENSITY (bytes/inch) × SPEED
(inches/second).

For example, with a tape density of 800 BPI and a tape speed of 200 inches per second, 160,000 bytes (characters) of data could be transferred between RAM and the tape (or 160K cps — characters per second).

No wonder magnetic tape is such a useful recording medium. It allows us to input and output at high speeds (much faster than we could read and write), and the data or program is reusable.

The only drawback of magnetic tape is that individual items stored on the tape cannot be accessed without searching through a lot of unwanted data. The search for selected items is sequential and may often extend through most of the tape. There are, however, other auxiliary storage devices which, for a price, can alleviate this disadvantage.

TAPE CASSETTES

Another medium used as secondary or auxiliary storage is the tape loaded into cassette. The cassettes you buy in record or department stores for recording music are appropriate for use in loading and storing programs and data. However, it is essential that the very best quality cassettes be selected, since poor quality tape will either break or fail to provide accurate recordings.

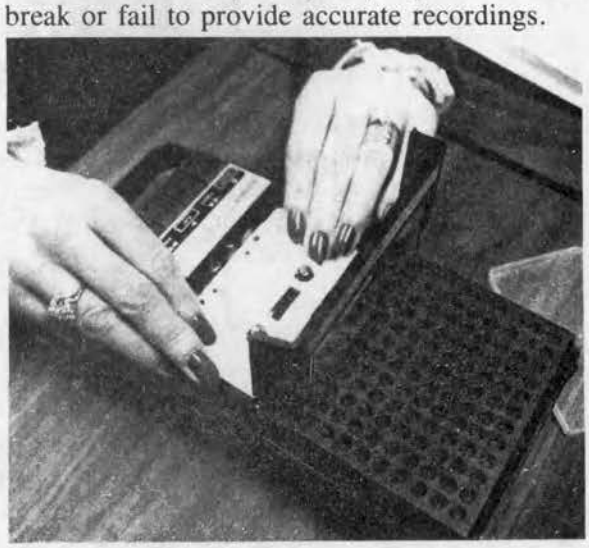


FIGURE 7—Using magnetic tape for computer data storage is exactly the same as when using it to record music on the family stereo.

Computers are much more particular about "reading" the contents of tapes than the typical stereo deck. And since tapes are read by the computer in the sequence programs and data are recorded, it is most often the case that users select tape cassettes in the 30 minute to 45 minute range rather than using the 60 or 90 minute ones.

FIGURE 8—Data cassettes and data cartridges are designed to meet very stringent specifications. For your initial programming requirements, good quality cassettes obtainable at a music or department store will be sufficient.

During this learning program, you will be using cassette tapes for loading and storing programs. After you have learned how to load, store, and access programs on cassette, it will be quite easy for you to use other media such as the floppy or hard disks available on various computer systems.

FROM A TO Z OR DIRECTLY TO ZEBRA?

Imagine that the contents of a huge, unabridged dictionary are stored on both magnetic tape and magnetic disk. You want to retrieve the stored information about the word Zebra. Since magnetic tape requires sequential access, the reader has to scan through the entire tape from A to Z in order to retrieve the information. Meanwhile, the magnetic disk reader goes immediately to Zebra and retrieves the information in a fraction of the time. Direct access is lightning fast!

FIGURE 9—Magnetic tape is a sequentially accessed medium. Floppy and hard disk media are direct access and, therefore, much faster in retrieving data and programs.

MAGNETIC DISKS

One of the trends in computer technology, as we have already seen, is the move towards miniaturization. This is not only true with computers themselves, but also with auxiliary storage devices.

Magnetic disks allow for data to be stored much more compactly than on tape. Data stored on disk can be located very quickly when all the information is tightly packed together.

Another advantage is that data stored on disk can be retrieved directly or by random access rather than sequentially retrieved as on tape. Random access means even greater retrieval speed. For these reasons, disks are the preferred media when very fast retrieval is required.

The disks, themselves, are hard metal or floppy plastic platters coated with a metal oxide capable of being magnetized in discrete locations to hold coded data. The data can be read from or written onto the disk only when the disk is inserted into a disk drive.

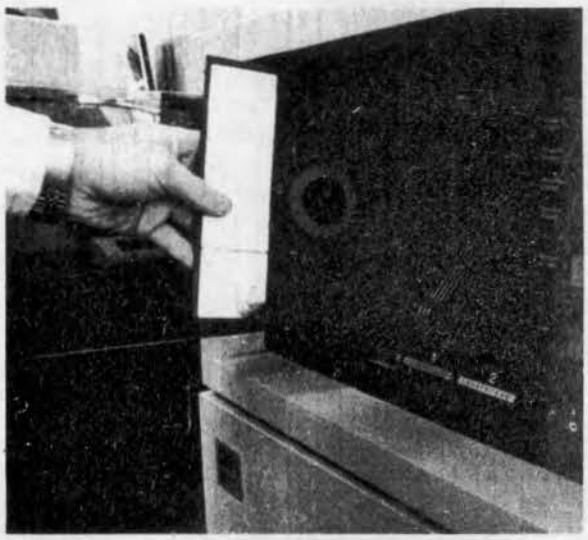


FIGURE 10—Magnetic disks come in a variety of sizes and densities. However, most systems are designed to use only one type of disk and size. The 5-¼ inch floppies, for example, hold approximately 80 pages of data per side while the 8-inch floppies can hold up up to 240 pages per side.

The disk drive rotates the disk at a very high, uniform speed. Access arms or actuators move above the surface in order to record data (output) or to play it back (input).

Magnetic disks can be purchased in many different sizes and formats. Floppy disks are used mainly in micro and minicomputers. Hard disks, although more expensive, can be bought for many different systems.

One benefit of the hard disk over the floppy is that hard disks are less likely to "lose" the file contents due to error, malfunction or other accident.

One advantage of the floppies is that they can be filed in plastic jackets, three-ring binders, behind file guides, or loaded into carrying cases for transport. They are available with single and double recording sides, and come with several recording tracks. A typical flexible diskette will contain as many as 77 tracks and have tremendous durability; some can be used over two million revolutions per track.

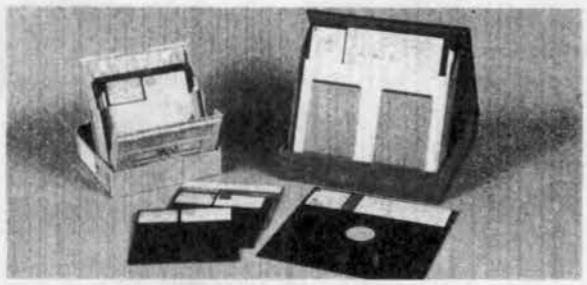


FIGURE 11—Floppy disks are often stored in special pockets within vinyl albums.

There are two ways in which data is recorded on magnetic disk: the cylinder track method and the sector method.

The Cylinder Track Method of Recording

It is common to think of disks as being similar to records used to play music. On record albums, data (music) is recorded in grooves which wind into the center of the platter.

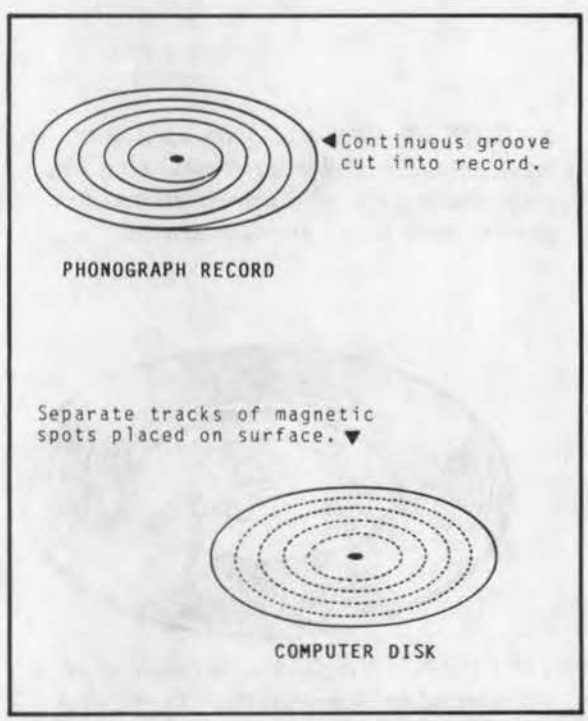


FIGURE 12—The phonograph and data storage disk would appear very similar until you examine the method of recording and look closely at the surfaces of each. Another major difference is that you never, never touch the surface of a data disk unless you want to ruin it!

The cylinder method, however, holds data in concentric rings. The "grooves" on a disk are not actually dug into the surface but are recorded data on the surface. Each of these rings is called a "track."

When several of the disks are stacked on top of each other, we have a "disk pack." Information is accessed from a disk pack by referencing it according to the distance the data is from the edge (its cylinder number) and the surface upon which it is located (its track number).

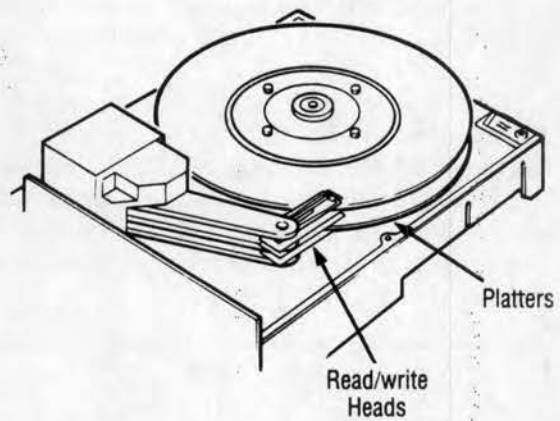


FIGURE 13—Disk packs are used in the larger minicomputers and mainframes. You can, however, obtain larger disk drive units and disk packs for use with many microcomputers.

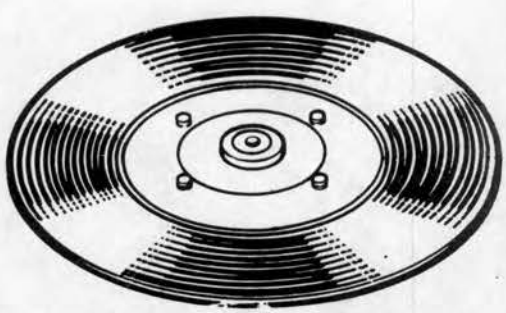


FIGURE 14—A rigid disk can store much larger volumes of information than floppy disks. The physical structure and speed of the rigid disk also give you significantly faster data transfer rates. The method of recording on rigid disk is very similar to the process used for floppy disk. The main differences are that the rigid disk is made up of two hard surface platters.

Sector Method of Recording Disks

In the sector method of recording, all tracks are divided into equal-sized sectors. Each sector is numbered consecutively on each track and disk. Data is accessed by specifying the sector number on which data is recorded.

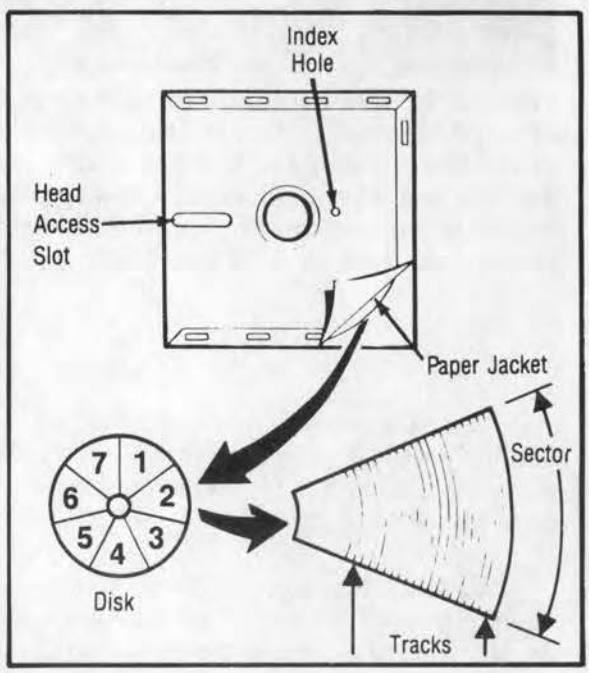


FIGURE 15—Notice how each sector is identified by number and each track is also equal in size.

While these different methods of magnetic disk storage may seem confusing at first, we, as programmers, have nothing to fear. The computer's own programs can actually move the access arms (or actuators) to the desired location, while we only request (in our program) that the data we wish to access be found. All that we have to do, in other words, is press the right keys!

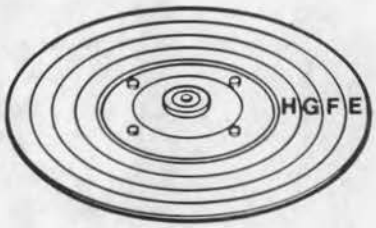


FIGURE 16—When a rigid disk is formated, it is divided into sectors and tracks much like the floppy disk. Each platter of the rigid disk will have as many as 256 tracks and each track will have 32 sectors. Each of the sectors can hold 256 characters, so the entire disk can hold over 8 million characters.

THE KEYBOARD

When data is directly recorded onto card, tape or disk, it is being collected so that it can be used at a later time. This procedure is called "batch processing," because the data is grouped into batches before the program to process it is under the control of the CPU.

In preparing monthly checking account statements, for example, a month's worth of transactions can be collected in a batch and customers' statements can be prepared when necessary. Large computers (in terms of storage capability) are most often used for batch processing. But in many other types of applications, more immediate processing is desirable.

In "transaction-oriented" or "real-time" processing, the data keyed by the operator is directly transmitted to the computer which, under control of the program, will do the necessary processing — and right then and there.

To use the bank again as an example, many bank administrators have their tellers key all transactions at the time they are made. With this type of "on-line" system, your deposits or withdrawals are posted against your balance immediately.

The microcomputer is especially well designed for this method of data input. Through the directly attached keyboard, a program may be entered, saved and modified.

Through the use of our computer, we can put a program under control of the CPU. The CPU can then issue "requests" for data to be entered. These requests for data are called "prompts."

FIGURE 17—Given the right program, this keyboard can provide instant checkbook balance with every check written and every deposit made. The input for each transaction is similar to what tellers do when you make withdrawals and deposits at the bank.

DATA COMMUNICATIONS

Very often, data is recorded at one location and has to be processed somewhere else. Data communications are involved. Data communications are the connecting of various devices and transmission lines so that data can be sent from an input device over telephone lines and received at the computer site.

The modem (modulator/demodulator) units convert the bits being sent in bursts of energy (digital data) into the more even wavelength frequencies used in communication (analog data) and vice versa. With a modem and an acoustic coupler

FIGURE 18—Here is an example of how several terminals can be connected in remote locations for use with a computer. The system uses ordinary telephone lines to communicate.

(a device for connecting the telephone receiver to the computer), many microcomputer users can have access (at a fee!) to many large computers all over the world. In other words, a very small microcomputer can have access to data and programs from extremely large mainframes.

Telephone lines are not the only communication vehicles for long distance data transmission. Today's high-technology civilization boasts such other advances as microwave lines, satellite communications, coaxial cables and fiber optics. At this time, however, these methods are far too costly for the average microcomputer user.

We have now seen several devices used in getting data into computer memory. But one word of caution is in order. The data processing world often speaks of "GIGO" (Garbage In/Garbage Out), which is another way of stating one of life's axioms: you only get out of an endeavor what you put into it. No matter how sophisticated the data

FIGURE 19—Here is a working system with text editors located in several cities. It furnishes financial data to the corporate headquarters every day.

operation gets, the input of invalid data to the computer will not result in the data being processed accurately.

Now pause for a moment and see what you have learned. Complete the Programmer's Check and verify your answers before continuing.

PROGRAMMER'S CHECK

1

Input Check

Answer the following questions and check your answers. If you miss one or more, then you should review and study your lesson thoroughly before proceeding.

1. **Which of these provide input to computer memory?**
   - **(A) The keyboard**
   - **(B) The punched card**
   - **(C) Magnetic tape and disk**
   - **(D) All of the above**
2. **Data is recorded on a card by which of the following devices?**
   - **(A) The verifier**
   - **(B) The data capturer**
   - **(C) The keypunch**
   - **(D) None of the above**
3. **The code used to represent data on a card is called the**
   - **(A) hexadecimal code.**
   - **(B) hole punch code.**
   - **(C) CIBE code.**
   - **(D) Hollerith code.**
4. **A modem is used to**
   - **(A) communicate via telephone from a terminal to a computer processor.**
   - **(B) communicate from MPU to a CPU.**
   - **(C) communicate from RAM into ROM.**
   - **(D) communicate from user to keyboard.**
5. **Data communications require all of the following except**
   - **(A) GIGO.**
   - **(B) modem.**
   - **(C) transmission lines.**
   - **(D) a computer.**

(Answers on Page 12)

PROGRAMMER'S CHECK ANSWERS

1

1. (D) **All of the above.**
2. (C) **The keypunch.**
3. (D) **Hollerith code.**
4. (A) **Communicate via telephone from a terminal to a computer processor.**
5. (A) **GIGO.**

OUTPUT DEVICES

We have now explored two-thirds of the data processing cycle. Now let us examine the ways in which useful informtion can be extracted from computer memory — output. After all, what good is a computer if it cannot tell us more than what we have given it?

Two devices are most often used in presenting output which is readable by people: the CRT (monitoring screen) and the printer.

FIGURE 20—Here is an example of a portable computer in which the CRT is build into the unit. Notice that it can also be plugged into a regular television monitor to take advantage of the larger screen.

THE CRT

CRT is the abbreviation for **CATHODE RAY TUBE**, which is really nothing more than a regular television screen. You will frequently hear these devices called display stations, terminals or monitors. The purpose, of course, is to allow data to be shown on the screen in a way similar to the display of picture signals we receive on our TV set at home. In this case, however, the "antenna" leads are connected to the computer directly.

When data is displayed on a screen, it must be presented in a format which is clear to the user. Too much data displayed on the monitor can cause confusion; too little, and we may lengthen the amount of time necessary to find out what we are looking for.

When displaying data, CRTs generally work in the text or graphics mode (or a combination of both). In the text mode, the screen is divided into from 10 up to 25 lines with 32 to 80 columns per line. When in this mode, the computer is able to print out its information like a page of a book. Programs, letters and business reports are best displayed in the text mode.

When the computer is displaying its output on the screen in the graphics mode, the screen is divided into a much tighter grid with more rows and columns. The ability of a program to produce bar graphs, pie charts or to simulate arcade-style video games depends on the computer's graphics capability. The tiny spots on the screen which can be individually displayed are called pixels, which is short for "picture elements."

These pixels can be either dark or light. CRTs which can only display two tones (black and white or green and white, etc.) are called monochrome displays. The accurate true-to-life lines and circles displayed on better quality CRTs is a factor of the number of pixels per square inch of the screen. In other words, its resolution determines quality.

The software and CRT are provided with color capability on some computer systems. Up to 16 colors can be used to "paint" pictures on the screen. The quality of the colors and picture depend on the resolution of the color monitor.

When a computer with a CRT is first turned on, we usually are presented with a command screen. Each computer's command screen is different. However it actually appears, the computer is giving the user the opportunity to begin any job the system is capable of handling. (This would include writing a program, running or loading a program, etc.)

You will learn to write programs in a format which is termed "menu-driven." A menu on a computer program is very similar to a menu you get at a restaurant. The menu lists a choice of available food items. When displayed on a CRT, a menu lists several available things that the computer is programmed to do.

Such menus make it easy for the user to make selections for inputting data and commands. And some menus command the computer to perform several functions with just one key depressed by the operator.

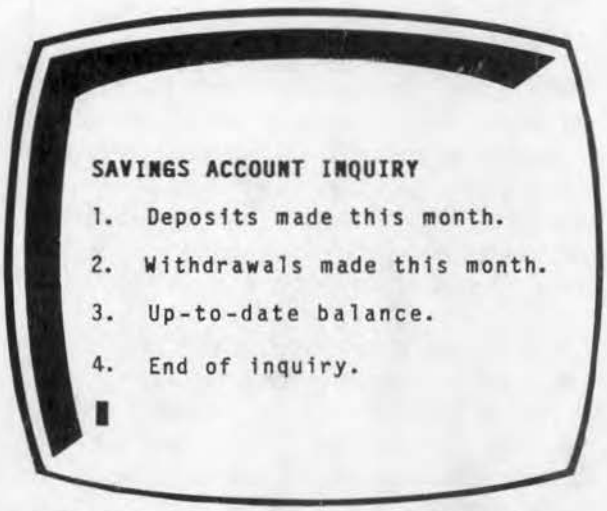


FIGURE 21—Here is an example of a bank computer menu. The user is asked to choose items from a series of selections displaying current information about a savings account. The user picks one of the four options by entering the appropriate number (1 through 4) in the bottom left of the screen. Note the solid block character in the bottom left of the screen. This is the cursor. Depending on the system, the cursor may be a solid block or an underline. Either way, it shows the user where any character depressed from the keyboard will be entered on the screen.

Entire programs which are largely menu-driven are said to be "user friendly," because the text displayed on the screen makes the operation of the computer relatively easy for the non-technical user. But developing a user friendly system is a challenge to the programmer, whose job it then is to keep all of the branches in the program where they are not visible to the operator.

FIGURE 22—Here is an example of a very popular word processing software program menu. These helpful reminders stay on the screen while the program is in use or until the operator has memorized them. Notice there are other menus listed which can be called up at the touch of the control key plus another key. One of these on this program happens to be a "Help!" menu to assist the user in locating different commands.

THE PRINTER

In many instances, a more durable form of output is desirable than an image on the CRT or data stored on tape. Output printed on paper is called "hard copy" and is produced by using a printer of some kind. Hard copy can be produced in a variety of forms and sizes, from small mailing labels to continuous form paper several hundred feet long.

Printers are among the most widely diversified of the computer peripherals. They can be classified by the way they print, as well as their

speed, letter quality, plotting capability, and versatility in using different forms. All of these factors influence the price of output printers. Costs range from less than $200 to millions of dollars.

The printer may be an electric typewriter modified to receive signals from a computer or it may be a large stand-alone machine capable of setting a variety of type sizes and styles at lightening speeds.

Print speed is closely related to the manner in which the printer works. Serial printers type output much like the average typewriter — one character at a time, moving from left to right. Then, there are some printers which are bidirectional. These printers print from left to right and right to left, continuously on alternate lines. Speeds of serial printers are measured in characters per second (CPS).

FIGURE 23—This is a tabletop model printer capable of bidirectional printing at a speed of 40 cps. It can produce type in 10, 12, and 15 pitch and proportionally spaced type using special print wheels.

Much faster than serial printers are line printers. These output devices write one line of text at a time and assemble the format of the line in computer RAM at CPU speed. Line printers can print from several hundred to several hundred thousand lines per minute.

Another criterion for measuring printers is the manner in which the characters are printed on the paper. Many print much like a typewriter, using round, golfball-like typing elements. Others use flat, spoked disks known as "daisy wheels." All the characters strike against a mylar ribbon which transfers the ink impression onto the paper.

Some high-speed printers "spray" jets of ink onto the paper without any sort of ribbon. Others use heat to "burn" their impressions on specially treated paper. The laser is also being used to print on electrostatic plates, making printouts literally at the speed of light.

Purchasers of microcomputers for the home and small business usually choose a medium priced dot matrix printer over the more expensive letter-quality single character printer. The dot matrix printer provides readable print and allows for a great variety of graphics as well. These printers are suitable for financial, accounting, production and other reporting tasks within the company or home.

Single character printers are used primarily where neat, typewriter-quality letters and reports are required. Companies having a high volume of external correspondence and word processing tasks would choose printers which produce attractive and professional looking results. Letter-quality printers are also preferred by attorneys, writers and corporate executives.

A dual purpose printer can be obtained by purchasing an electronic typewriter with memory. These cost more than a standard electric typewriter, but considerably less than the commercial quality printers. When not being driven by the computer, these typewriters can be operated separately as normal typing machines. Most manufacturers can provide the connectors and adaptors required for hooking up electronic typewriters to various models of microcomputers.

When choosing a printer, you must first evaluate your needs. A large bank might need to generate thousands of account statements every day and would, therefore, require several high-speed, reliable printers. The average microcomputer user generally produces much less hard copy

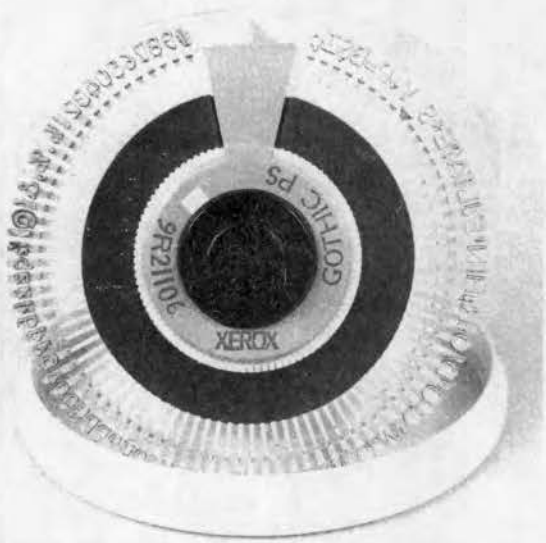


FIGURE 24—Daisy wheel type elements come in a variety of sizes and also with proportional spacing. They can be interchanged quickly and easily.

output, and almost any of the lower-cost serial printers would be more than sufficient.

TAPE DRIVES

Recording (output) data and retrieving (input) data stored on magnetic tape is acccomplished by using tape drives. Tape drives come in all sizes and prices ranging from the simple, inexpensive portable tape recorders all the way to huge multi-tape drives used in mainframe computer systems.

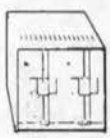
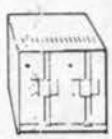
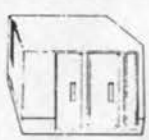
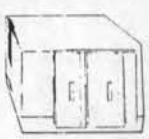
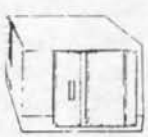
Regardless of the size or type of tape drive, the manner in which data is recorded and retrieved is quite similar. The tape is mechanically stretched to an even tension and run at a constant rate of speed over magnetically sensitive read/write heads.

To record, data is passed along cables from the RAM as output to the tape drive. The write head is where the bit patterns are transferred onto the tape in the form of magnetized spots on the appropriate channel.

```
Although printers come in a tremendous array of
shapes and sizes, there are only two basic types
suitable for interfacing with micros: dot matrix
printers and letter quality printers. Dot matrix
printers generate characters by printing patterns
of dots. Each letter, number and symbol is formed
by placing dots in appropriate places inside a
rectangle so that the result looks very much like
the desired character. Since only patterns of dots
are used, special symbols and graphics can be
created easily on dot matrix printers by arranging
the dots in different locations in the rectangle.
The dots are printed on paper by either tiny
hammers striking a ribbon or by tiny ink jets shot
```

FIGURE 25—This is an example of a dot matrix printout. Notice that the characters are formed using tiny dots in patterns. Such printers are good for normal utility jobs in which the information is more valuable than its appearance. Financial data, in-house manuscripts, reports, and memoranda can be produced on these less expensive printers. For "letter quality" and camera-ready printing, however, a higher quality printer is required.

DISK DRIVE OPTIONS

COMPONENT	DATA STORAGE CAPACITY	DISK PARAMETERS
5¼" Single Sided Dual Floppy Disk Drives 	Single Density Disk holds 40 pages Double Density Disk holds 70 pages	SINGLE DENSITY / DOUBLE DENSITY 128 / 256 Bytes/Sector 18 / 17 Sectors/Track 40 / 40 Tracks/Disk 3 / 3 #Tracks reserved for system use 81K / 155K Disk capacity after formatting
5¼" Double Sided Dual Floppy Disk Drives 	Single Density Disk holds 80 pages Double Density Disk holds 140 pages	SINGLE DENSITY / DOUBLE DENSITY 128 / 256 Bytes/Sector 18 / 17 Sectors/Track 80 / 80 Tracks/Disk 3 / 3 #Tracks reserved for system use 172K / 322K Disk capacity after formatting
8" Single Sided Dual Floppy Disk Drives 	Single Density Disk holds 120 pages Double Density Disk holds 240 pages	SINGLE DENSITY / DOUBLE DENSITY 128 / 256 Bytes/Sector 26 / 26 Sectors/Track 77 / 77 Tracks/Disk 2 / 2 #Tracks reserved for system use 241K / 482K Disk capacity after formatting
8" Double Sided Dual Floppy Disk Drives 	Single Density Disk holds 240 pages Double Density Disk holds 480 pages	SINGLE DENSITY / DOUBLE DENSITY 128 / 256 Bytes/Sector 26 / 26 Sectors/Track 154 / 154 Tracks/Disk 2 / 2 #Tracks reserved for system use 490K / 980K Disk capacity after formatting
8" Rigid Disk Drive 	The Rigid Disk holds up to 4000 pages of material. A Double Sided 8" Floppy Disk Drive is provided with the 8" fixed disc drive.	Rigid Disk Parameters 256 Bytes/Sector 32 Sectors/Track 1024 Tracks/Drive 8.19 M-Byte Usable Capacity Double Sided 8" Floppy Disk Drive provided for back-up and transfer

Each page of disk capacity is equal to 2000 characters.

Each **K** of disk capacity is equal to 1024 characters (bytes).

FIGURE 26—Many systems offer the option of one or more disk drives.

The ability to record and store (output) data, impressive though it may seem, would be useless unless we can retrieve what has been recorded. This is accomplished by repositioning the tape to the beginning of our data and placing the tape drive in a "read" mode.

The read head is connected into the computer's RAM. The read head senses the magnetized spots at each tape position as the tape moves across it, sending the corresponding bit patterns back into consecutive bytes of RAM.

Just as when you record music on a previously recorded tape, the new version replaces (erases) the old version as you record. Protective devices can be used to prevent accidental erasure of important data.

While a technical perspective on how those recording/playback features actually work is a subject best left for electrical engineers, the power of the computer to execute these actions is simply performed. As long as the tape is properly installed, we merely enter a "SAVE" command from our keyboard in order to record our program. A "LOAD" command will bring a previously saved program back into RAM from a tape.

FORMATS OF PRINTED REPORTS

One of the great advantages of producing reports and other printed information on computer is the ability to arrange the information exactly as you want it on the screen of the CRT before touching the "print" key. If the proper software is in the computer to assist in formating the material, letters, reports, invoices, etc. can be reproduced exactly as they appear on the CRT.

Clarity and accuracy are the two essential elements in creating computer job formats. And, with the emphasis upon programs designed to provide users with financial data, the financial report is one of the major forms you will be expected to know how to format.

A "detailed" report is a listing of all information used in preparing the report. A "summary" report lists only totals—not the individual data of the detailed report. An "exception" report lists only that information deemed by the program to be unusual or extraordinary.

Let's look at how these three different types of reports might appear, when applied to a business situation. When working on an inventory control report, for example, data must be gathered on the various items in stock such as:

1. part number
2. part description
3. unit price-cost
4. sales price
5. quantity on hand
6. quantity on order
7. size

Let us say that after a careful counting of our inventory, the following sheets have been completed, as shown in Figures 27 and 28.

With the departmental inventory data entered and stored in memory, many different reports can be produced. For example, a detail report would probably show the sub totals for each type of item, quantity of similar items, etc.

DEPARTMENT 1Ø INVENTORY

JANUARY

Item	Size	Description	Cost/Unit	Price Unit	Quantity On Hand	Total
11Ø	1/4"	Nails	$1.5Ø/box	$2.5Ø box	1ØØ	$25Ø.ØØ
111	3/8"	Nails	$1.75/box	$2.85 box	5Ø	$142.5Ø
148	6Øw	Bulbs	$ .75/4pk	$1.1Ø 4pk	751 4pk	$826.1Ø
149	75w	Bulbs	$ .8Ø/4pk	$1.1Ø 4pk	3Ø 4pk	$ 33.ØØ

FIGURE 27—A detailed report for a department.

DEPARTMENT 2Ø INVENTORY

JANUARY

Item	Size	Description	Cost/Unit	Price	Unit	Quantity On Hand	Total Amount
215	L	M/T Shirt	$1.ØØ ea	$1.85	ea	4Ø	$74.ØØ
225	M	M/T Shirt	$1.ØO ea	$1.85	ea	25	$46.25
235	S	M/T Shirt	$1.ØØ ea	$1.85	ea	74	$136.9Ø

FIGURE 28—Each department would complete a detailed inventory.

On the other hand, a summary report would give the totals for each department as in the example below:

INVENTORY SUMMARY FOR JANUARY

```
Department 1 ..............$2Ø,ØØØ.ØØ
Department 2...............$   238.2Ø
Department 3...............$ 5,45Ø.1Ø
Department 4...............$14,982.7Ø
```

FIGURE 29—The store manager wants to receive a summary report showing totals.

Now, suppose the store manager wanted to know how many items need restocking. The manager could request an exception report showing all items whose quantities were below 50. Such a report might trigger the placement of an order from the manufacturer or distributor of each product. Figure 30 is an example of an exception report.

Business reporting is very useful in such applications. Inventory control, payroll, accounts receivable and payable, general ledger, budget reports, profit and loss, and income statements are some examples.

Most CRTs are capable of displaying a maximum of 24 instructions on the screen at a time. When very long reports are to be reviewed, a "scroll" device is used. By scrolling, the programmer is able to display the other lines of the program as desired—but only at the maximum of 24 lines.

Often, it is desirable to be able to debug a program (get any errors out) by examining the entire program at once. For this purpose, the programmer obtains a hard copy off the printer. After identifying all the bugs on the hard copy, the program and/or data can be modified accordingly.

Word processing and mailing applications require their own forms of printed output. In a direct mail advertising application (as in the junk mail advertising contest materials we receive

DEPARTMENT 2Ø INVENTORY

JANUARY EXCEPTIONS

Item	Size	Description	Cost/Unit	Price	Unit	Quantity On Hand	Amount
215	L	M/T Shirt	$1.ØØ ea	$1.85	ea	4Ø	$74.ØØ
225	M	M/T Shirt	$1.ØØ ea	$1.85	ea	25	$46.25

FIGURE 30—The exception reports will indicate which items need replenishing.

continually in our mail), letters promising millions in prize money are sent to us in a personalized manner.

Utilizing the proper computer system with appropriate software and printing, it is a relatively simple matter to store the text of the letter in memory along with thousands of potential customer's names and addresses.

A program can be developed to "insert" each name and address into the body of the letter. The result is a personalized message created with enormous savings in money and time over what it would cost to have individually typed letters. The paper usually has the text already copied by a professional printer; the computer printer merely writes in the changeable data.

With new software and special forms, mailing labels for various applications can also be printed. Imagine the high volume of prospective customers who can be contacted using personalized letters and mailing labels. Consider, too, that the entire project can be done with a minimum amount of manual labor.

Several cautions are worth mentioning here. Printed output does have certain limitations which should be of concern to the user.

- Paper costs money. Special forms are even more expensive than regular paper. Although paper can be recycled, it is essentially useless and/or wasteful, once the data recorded on it becomes outdated.

- The speed at which even the fastest printer prints is many times slower than CPU speed. The more output we need to produce, the slower our program will run. (When this happens, the system is said to be "I/O bound.")

- Paper reports occupy physical space. Even one month's worth of daily reports can fill up a storage room very quickly.

December 5, 1982

Ms. Marge Coul
7631 Juliette
Huntingtn, Ca

Dear Ms. Coul

On December 26th, you'll be celebrating something special ... your 28th birthday. If you act before that date, you're eligible to apply for $10,000.00 in valuable life insurance protection...at a monthly premium that will never be lower than right now!

This is whole life insurance protection where premiums are based on age. If you return the application before December 26th, your monthly premium will be $11.10, billed with your JCPenney charge account. And your rate will not increase as you grow older.

If you apply after your birthday, the insurance will still be available. But, since life insurance premiums are based on age, the longer you wait to buy, the higher the rate. So, when December 26th rolls around and you turn age 28, you move up to a higher rate.

The important thing is, if you act now, you'll be saving money on your premiums every month from now on, because -- once you have your policy -- the rate does not go up as you grow older.

FIGURE 31—You have probably received many "personalized" advertisements in the mail. The format of the letter is either preprinted or else duplicated on computer. The name and address of the recipient is automatically merged from a list containing possibly thousands of names.

FIGURE 32—These 30,000 documents can be stored on a few floppy disks or cassette tapes. Double density eight inch floppies hold as much as 240 pages of copy on a side.

- Because they have many moving parts, printers tend to break down more frequently than any other peripheral device. This down-time can be a hidden cost to a company dependent on its printed output.

PLOTTERS

There is a category of printer capable of making hard copies of the black and white and color output corresponding to the graphics that CRTs can produce. These devices are generally more expensive than normal printers, but are capable of producing visually pleasing reports.

Some use a variety of colored inks and can produce designs which border on fine art. Plotters are used by drafters in designing homes, communication systems, and other engineering applications, too.

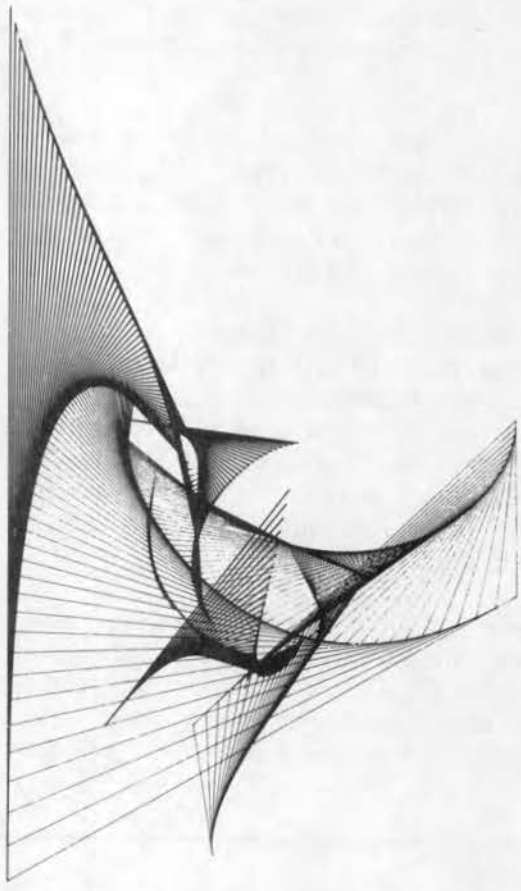


FIGURE 33—Here is an example of an artistic design using a plotter and eight colored ball point pens. This programmer created 365 different designs and presents them to friends on their birthdays. More serious applications include tracking sales, production, the national economy, and the weather.

AUDIO OUTPUT

Given an on-line voice synthesizer, computers can be made to produce spoken output. Unfortunately, most output is in a boring, monotone voice and the vocabulary is limited. A piano keyboard can be added for those who want to compose music, too. The audio music is familiar to anyone who has played video games.

Let's pause a moment and take the Programmer's Check on the next page to see how much you have learned.

PROGRAMMER'S CHECK

2

Reviewing the Output

Answer the following questions and check your answers. If you do not answer them all correctly, review your lesson before continuing.

1. **Which of the following is strictly an output device?**

   (A) The keyboard

   (B) The CRT

   (C) The magnetic tape

   (D) The punched card

2. **A CRT is most familiar to us as a**

   (A) printer.

   (B) character radio transmitter.

   (C) TV screen.

   (D) magnetic tape.

3. **The monitor displays output in which of these formats?**

   (A) Serial and line modes

   (B) Text and graphics modes

   (C) Single character and dot matrix

   (D) Magnetic tape and magnetic disk

4. **"Menus" are especially appropriate for which reason?**

   (A) They aid programmers in writing programs.

   (B) They verify input data.

   (C) They aid non-technical operators in using programs.

   (D) They serve no useful purpose.

5. **Printers are evaluated using which of the following criteria?**

   (A) Speed

   (B) Print type

   (C) Cost

   (D) All of the above

6. **Which of the following is not a format of a printed report?**

   (A) Summary report

   (B) Exception report

   (C) Dot matrix report

   (D) Detail report

7. **When selecting a printer, it is most important to determine**

   (A) speed.

   (B) cost.

   (C) appearance.

   (D) need.

(Answers on Page 22)

PROGRAMMER'S CHECK ANSWERS

2

1. (B) **The CRT.**
2. (C) **TV screen.**
3. (B) **Text and graphics modes.**
4. (C) **They aid non-technical operators in using programs.**
5. (D) **All of the above.**
6. (C) **Dot matrix report.**
7. (D) **need.**

ROBOTIC OUTPUT

Visit most textile mills today and you will see only one or two people supervising dozens of whirring machines. Each loom is now being operated by its own computer program and CPU. A step further are robots which actually replace bolts of cloth, thread spools, and perform other functions once done by humans.

Computerized tools can now weld metal, sand surfaces, install parts, and tighten bolts on auto assembly lines. Robotics is one of the newest applications of computers. At least one mail order house advertises a house robot butler which will meet and greet you at the door, serve you beverages, let the dog or cat out, load the washer and do the vacuuming.

DATA ORGANIZATION

When it is necessary to maintain large volumes of data, a systematic method for recording information needs to be used. We have seen how a group of bytes can be used to store a name, an amount, etc. In data processing, these units of data are commonly referred to as "fields."

A grouping of related fields is called a "record." A grouping of related records is called a "file." Let's look at an example of this.

If we wanted to have all the information from our address book organized for the computer, we are actually trying to maintain an address file. Each of the pages in the book would be a record. Each record would contain fields such as name, street and street number, town, state, zip code, telephone number, etc.

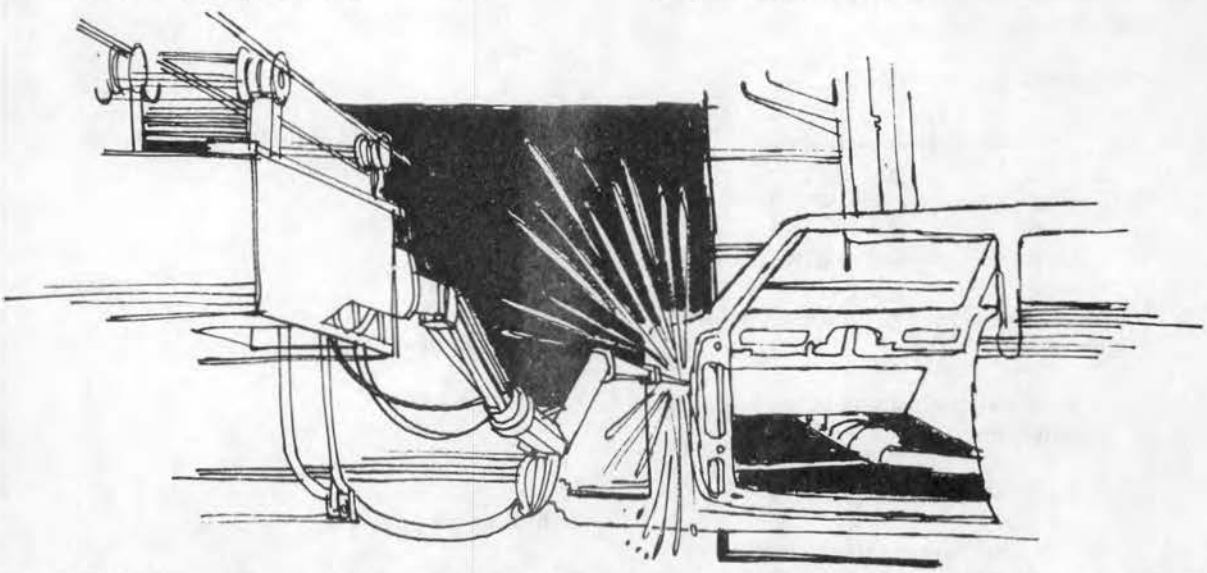


FIGURE 34—Computer controlled machines play a major part in the worldwide effort to modernize industry. With proper programming, installation and servicing, these robot-like machines can produce products with amazing consistency.

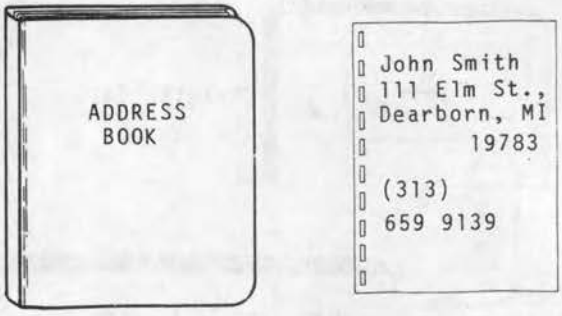


FIGURE 35—The organization of a data file is much like an address book. Within the file are records with specific fields of information.

THE BASIC PROGRAMMING CYCLE

So far, you have seen how data and programs are entered into the computer and you have learned how a computer processes data. You have also seen how output is obtained. The basic programming cycle is continuous.

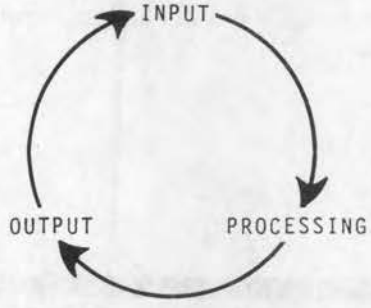


FIGURE 36—The programming cycle is always constant as new data and programs are required.

In the first step we collect and submit the data for processing. Next, under control of our program stored in RAM, the data is manipulated. Finally, the last step, the results of our (and the computer's) efforts are written or displayed as output.

EMPLOYEE MASTER FILE

NAME	HOURLY RATE
John Jones	8.74
Debra Cravy	9.24
Harvey Keene	7.5Ø

FIGURE 37—Here is a typical payroll application. Imagine that we already have a file containing each employee's name and hourly rate of pay. A master file can be produced quite easily.

	John Jones	Debra Cravy	Harvey Keene
Day	Hours	Hours	Hours
M	8	8	8
T	7	4	4
W	8	Ø	8
T	Ø	8	7
F	8	7	8
S	4	8	Ø
S	Ø	Ø	Ø

FIGURE 38—If the master file is to be created accurately, each employee time card file must be updated on a weekly basis.

Here is an example of this interaction between the CPU, RAM, ROM, and the input/output units.

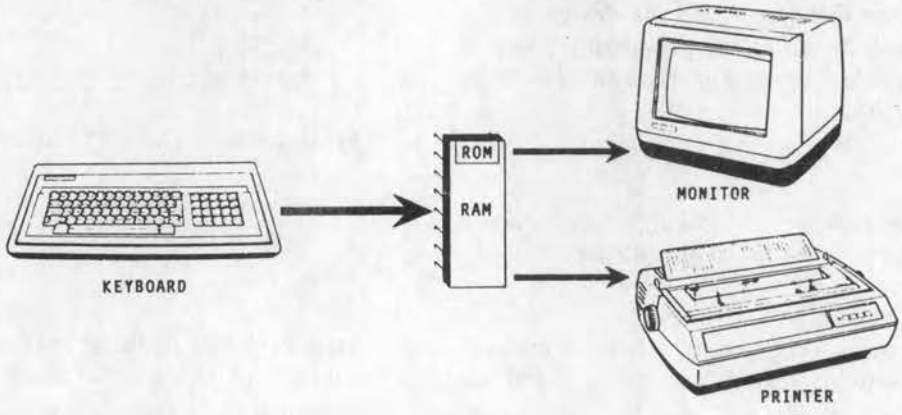


FIGURE 39—The interaction is always present among computer components.

The time cards for individual employees and the master card files are excellent examples of how data may be developed, inputted on a weekly or daily basis, then outputted as required.

The processing of these files will be controlled by a pre-written program which will be loaded into computer memory. It will contain instructions to examine each record from the two files, match up the master record data with the time card data for each employee, and then calculate the gross pay for each worker.

Additionally, a total of the entire company's weekly payroll will be accumulated. This program will then direct its results to the output unit, in this case, a TV monitor.

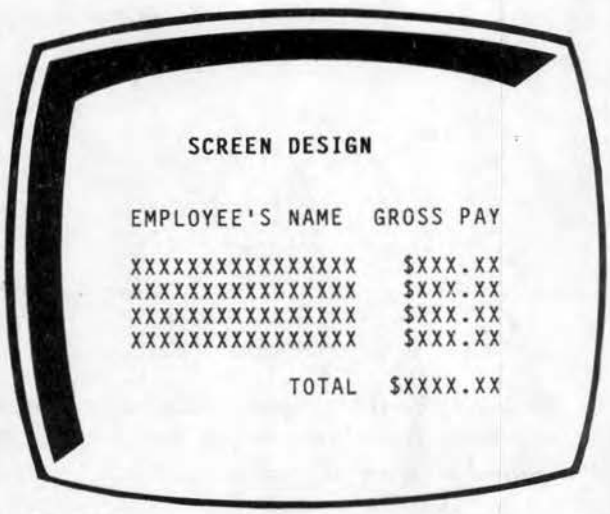


FIGURE 40—The output of payroll data would appear on the screen similar to what is shown here. Note the use of "X" in the design of the output. It will be up to the processing to print each employee's name and gross pay and the total in place of these.

Let's see how this payroll application can be made to work in terms of the data processing cycle.

Step 1. First, the program, which has been written and thoroughly tested, is input to RAM via an input device. In this instance, we'll use a tape cassette used in a portable tape drive unit.

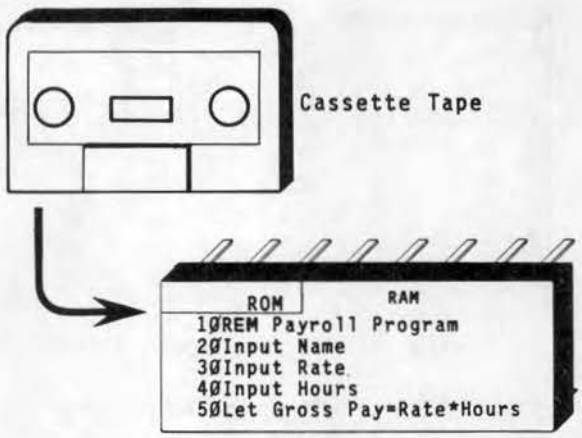


FIGURE 41—Inputting to RAM. The REM in line 1Ø is a remark (comment) statement which merely identifies the program to the user.

Step 2. Once the program is loaded into memory, the computer is then commanded to execute it. In this step, control over the program is given over to the CPU. The first instruction is fetched into the instruction register and the appropriate action is taken.

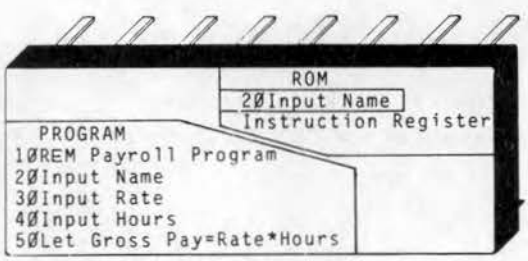


FIGURE 42—The CPU takes over.

Step 3. Some of these instructions request that data be submitted as input. When these instructions are encountered, a prompt will appear on the screen asking that the data be entered.

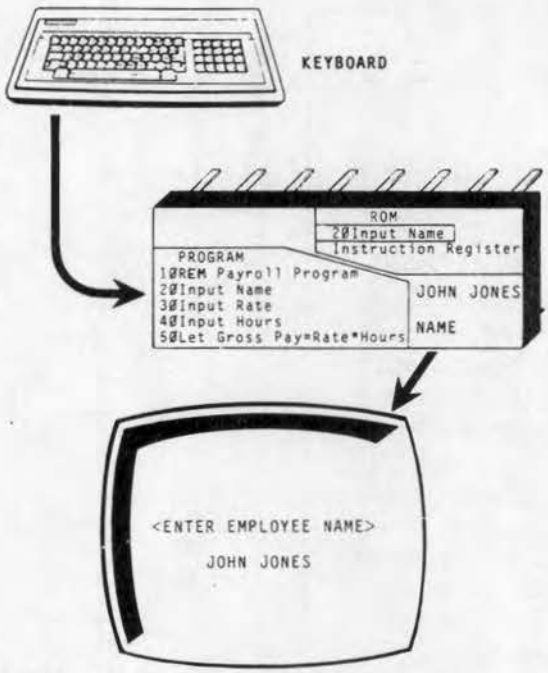


FIGURE 43—Prompts ask for input.

As each piece of data is keyed from the keyboard, it is stored in RAM and also displayed on the screen (so the operators can be sure that the proper data is entered).

After all of the input has been stored, the sequence of program instructions will begin to place into the instructions register commands for certain arithmetic operations. These calculations will result in gross pay totals for each employee.

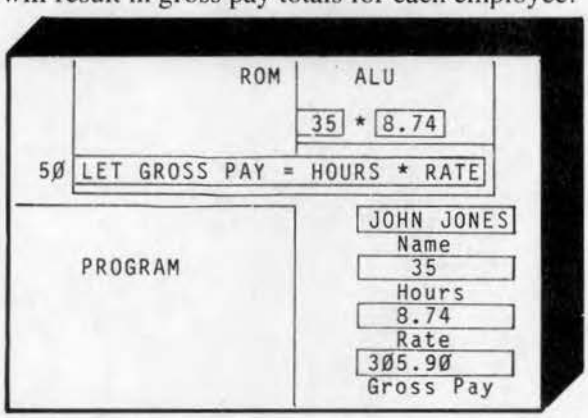


FIGURE 44—This is how the inside of the CPU might look in translation.

Step 4. When the calculating operations have concluded, this program will send its output to the TV monitor in the format previously designed.

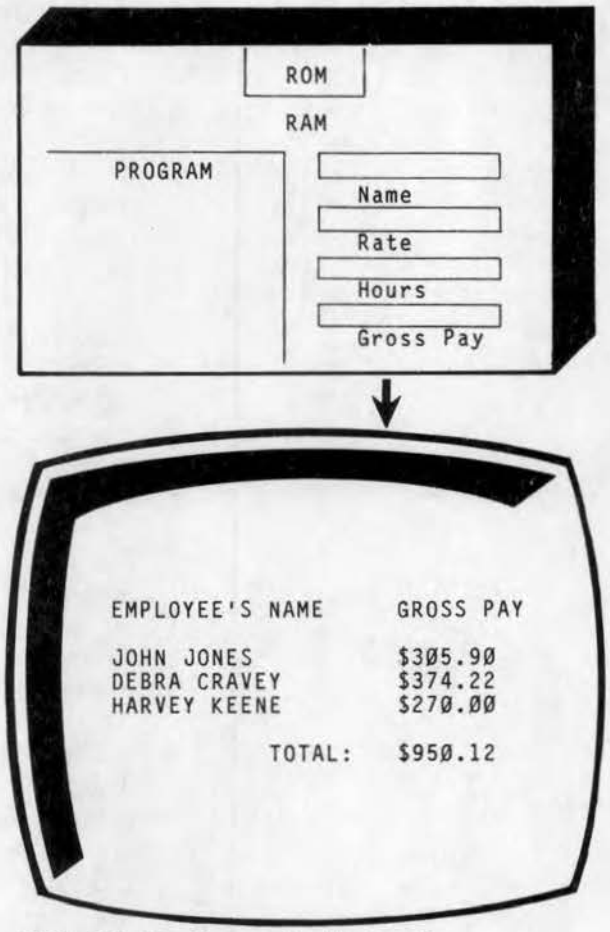


FIGURE 45—Output is displayed.

This program could be much more complex. Besides the calculations already shown, other data could be entered to determine deductions (e.g. state and federal taxes, health insurance, social security, and retirement).

There could be commands for updating the company's accounting ledger and to even produce payroll checks. But the basic processing cycle of input, processing and output will remain the same in every instance.

Perhaps you have realized that if we misspell an employee's name or mis-key the pay rates or hours worked, the computer has no way of correcting them and the output will be wrong. Remember, GIGO!

At this point, we have examined the inner workings of the computer: its input, output and auxiliary storage devices. We also have seen how these various components work together.

DO YOU KNOW NOW?

These were the questions posed at the beginning of the lesson.

- **All the various components of a computer system?**
  In addition to the computer with its microcircuitry (CPU, ROM, RAM), there are input devices such as card readers and keyboards; output devices such as CRTs, plotters, and printers; and auxiliary storage devices such as magnetic cassette tape or disk drives.

- **What "real time" processing is?**
  "Real Time" processing is a procedure by which data is entered into the computer and processed immediately as opposed to batch processing in which data is collected first and then processed later.

- **What "GIGO" is?**
  This term stands for Garbage In/ Garbage Out, which is to say the output will be no better than the input. Careful programming and verification are two of the means by which we ensure that our input is not "garbage."

SCHOOL OF COMPUTER TRAINING

EXAM 3

THE SYSTEM AND THE SOFTWARE

24703-2

Questions 1–20: *Circle the letter beside the one best answer to each question*

1. The data processing cycle is composed of

   (a) keyboard, RAM and tape.
   (b) input, processing and output.
   (c) processing, output and storage.
   (d) input, CPU and storage.

2. The IBM card has the following number of card coding locations:

   (a) 50
   (b) 16K
   (c) 80
   (d) 100

3. Using the Hollerith code, letters are coded with

   (a) one punch per column.
   (b) two punches per column.
   (c) three punches per column.
   (d) four punches per column.

4. "Computer Errors" are very often nothing more than

   (a) ROM errors.
   (b) data entry errors.
   (c) RAM auxiliary errors.
   (d) CRT errors.

5. The component used to check the accuracy of punched cards is a

(a) verifier.
(b) RAM.
(c) disk drive.
(d) keyboard.

6. The number of channels on standard magnetic tape are

(a) two.
(b) four.
(c) seven.
(d) nine.

7. Auxiliary storage is the same as

(a) main storage.
(b) secondary storage.
(c) ROM storage.
(d) RAM storage.

8. The method of access for cassette tapes is

(a) random.
(b) hard disk.
(c) floppy disk.
(d) sequential.

9. If you were preparing monthly checking account statements and stored a month's worth to process at the same time, this would be an example of

(a) key punching.
(b) random processing.
(c) "real time" processing.
(d) batch processing.

10. A modem is used to

(a) communicate from user to keyboard.
(b) communicate from MPU to keyboard.
(c) keyboard data to ROM.
(d) communicate via telephone from a terminal or computer to another computer.

11. Progams, letters and business reports are best displayed on the CRT in

(a) the storage mode.
(b) the text mode.
(c) the disk mode.
(d) the graphics mode.

12. Graphics require a CRT screen with

(a) a tight grid of rows and columns.
(b) fewer rows and columns than the text mode.
(c) the same amount of rows and columns as any other mode.
(d) a green and white or monochrome screen.

13. Resolution refers to

(a) CPU storage.
(b) RAM memory.
(c) the quality of the CRT image.
(d) auxiliary disk storage.

14. Menu-driven programs are said to be

(a) difficult to use.
(b) less desirable than custom designed programs.
(c) user-friendly.
(d) less reliable than others.

15. A plotter is one form of

(a) disk storage.
(b) compiler.
(c) printer.
(d) keyboarding input.

16. When discussing serial printers, "cps" refers to

(a) computer printer speed.
(b) character input speed.
(c) computer production sequence.
(d) characters per second.

17. The maximum number of instructions most CRTs can display on the screen at any one time is:

(a) 16
(b) 21
(c) 24
(d) 28

18. "I/O Bound" describes what happens when

(a) there is more output than input being processed.
(b) there is more input to be printed than the printer can handle.
(c) there is an equal amount of in-bound and out-bound data.
(d) there is more output to be printed than what the printer can handle quickly.

19. Magnetic tape is mylar plastic coated with

(a) double density tracks.
(b) iron oxide.
(c) microgrooves.
(d) sectors.

20. In the sector method of recording on disks,

(a) all tracks are divided according to program and data size requirements.
(b) all tracks are divided into sectors of equal size.
(c) all tracks are limited to three sectors.
(d) all sectors are concentric circles.

When you have completed the entire Exam, transfer your answers to the answer sheet which follows.

ICS

ANSWER PAPER

To avoid delay, please insert all the details requested below

Subject PRACTICAL PROGRAMMING IN BASIC Course

Name

Address

Post Code

Serial Number: 2 4 7 0 3

Test No.: 1

Ed No.: 2

Student's Reference: Letters / Figures

Tutor's Comments

Grade	Tutor

Study the foregoing Question Paper and use it for your rough workings. Record your final answers in the matrix below by writing a cross (X), IN INK OR BALLPOINT, through the letter which you think is the correct answer. Submit ONLY THIS ANSWER SHEET to the School for correction. ALL QUESTIONS MUST BE ANSWERED.

1.	A	B	C	D
2.	A	B	C	D
3.	A	B	C	D
4.	A	B	C	D
5.	A	B	C	D

11.	A	B	C	D
12.	A	B	C	D
13.	A	B	C	D
14.	A	B	C	D
15.	A	B	C	D

6.	A	B	C	D
7.	A	B	C	D
8.	A	B	C	D
9.	A	B	C	D
10.	A	B	C	D

16.	A	B	C	D
17.	A	B	C	D
18.	A	B	C	D
19.	A	B	C	D
20.	A	B	C	D

21.	A	B	C	D
22.	A	B	C	D
23.	A	B	C	D
24.	A	B	C	D
25.	A	B	C	D